Microgravity: Always A Bad Hair Day

Zero gravity. Microgravity. They're the same thing, aren't they? Many people use the words interchangeably, but there *is* a difference, and to astronauts and scientists, the difference is significant. The prefix "micro" means very small (as in microscopic) and comes from the Latin word meaning "one-millionth." Microgravity, therefore, means a very small degree of gravity or gravitational force, rather than none at all—that would be zero gravity.

If you watch a Space Shuttle launch, you'll notice that the vehicle doesn't travel in a completely vertical direction. It accelerates in an arcing path out over the ocean until it reaches a speed of nearly 27,350 kilometers (17,500 miles) per hour. At this speed, the Shuttle effectively falls around the Earth, in what is called an orbit. The International Space Station (ISS) follows a similar orbit around Earth. Because the Shuttle and ISS are traveling at the speed and altitude required to maintain orbit, these spacecraft and all their contents—including people—are actually falling in a curved path that matches the curvature of the Earth. Since all the objects are falling at the same rate, they appear to float as if there was no gravity.

There is gravity, however. Gravity is what keeps the ISS and Shuttle from speeding away into space. Earth's gravity and a small amount of aerodynamic drag from the atmosphere still exert some forces on the spacecraft and their contents, but they are very small. That's why it's called microgravity, rather than zero gravity.

Because microgravity is a fact of life in space, that's where the best research on the subject takes place. Scientists have designed experiments to explore behaviors and reactions of plants, proteins, and other substances, and the Shuttle and ISS astronauts carry out the projects during the course of their mission. One of the most significant microgravity experimental projects of all, however, is the astronauts themselves. Daily life in space proves and explores many of the hypotheses scientists have developed over the years.

Floating food, hovering sleeping bags, and rising strands of hair: the images of life in microgravity are startling because they're so different from life on Earth. Astronauts all agree that floating through space is indeed fun, but it also presents challenges.

"On my first flight, I was making my way through parts of the Shuttle, and as I passed through an airlock, I saw lights on the floor," says Janice Voss, who traveled on STS-57 in 1993. Voss' brain was so disoriented from microgravity that it couldn't process all that was happening. As she went through the airlock, Voss didn't realize she was floating upside down, but when her mind started to reprocess the images, the entire flight deck seemed to do a summersault and righted itself to her vision. "In orbit, your mind's perception of where you are is easily fooled," says Voss.

The Physical Aspect

All fun and games aside, microgravity does take a toll on the human body. Heart and respiration rates are reduced, and there is a progressive loss of body weight and bone calcium during flights. Most of these effects are easily reversible upon return to Earth after short missions, and astronauts flying for more extended trips exercise vigorously to keep the body in as good health as possible.

Bodily fluids are redistributed, with less in the lower extremities, and more in the upper body. Without the pulls of normal gravity, blood doesn't flow downhill, but pools in the extremities including the face, hands, and feet, causing a puffy appearance. And without

that downward pressure, height increases. Body mass often decreases with a loss of muscular tissue from nitrogen depletion; the veins and arteries of the legs become weaker, anemia occurs, accompanied by a reduction in blood count. Astronauts report an overall feeling of weakness and loss of balance upon return to Earth, though recovery is nearly complete after a week.

The most serious concern is the loss of bone calcium that increases with the length of a mission and shows no sign of cessation. The calcium loss from bones subjected to extended microgravity takes place at 10 times the rate of an elderly person suffering from osteoporosis. Because bone deterioration continues as the mission continues, some scientists believe we should find a way to simulate Earth's gravitational force on space missions. This is an aspect of gravity that Sir Isaac Newton certainly never considered when he pondered that falling apple.

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